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### SLIDES: Summary: Sources of Stress and the Changing Context of Natural Resources Law and Policy in the New West

William R. Travis

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## Summary:

### Sources of Stress and the Changing Context of Natural Resources

#### Law and Policy in the New West

Dr. William R. Travis

Department of Geography  
University of Colorado at Boulder

While the American West holds no exclusive charter on natural resources law, it has acted as crucible for natural resource and conservation practice, and served as host to important debates over water, species, forests, range, and energy policy—to which previous versions of this very conference bear evidence. The West holds the lion's share of the nation's carbon energy supply, and because it remains the least developed of American regions and the most dominated by public lands, it also provides the setting where the nation has established the largest national parks (in the conterminous U.S.) and where species protection and restoration plays out most prominently.

To my mind the future of the West and the future of natural resources policy, are closely bound together, and, I believe that future is one in which large, enduring forces, of both nature and society, are on a collision course.

#### Socio-Demographic Trends

The demographic momentum of the West is remarkable: the region is growing faster than the nation as a whole, and has done so for much of its history (Figure 1). And this growth is remarkably balanced across all the forces that can grow a regional population: the West is the preferred landing spot for international immigrants to the U.S. (documented and undocumented), it is the preferred target of domestic immigrants, especially from the Midwest and Northeast, and it is the most fertile and youngest part of the U.S. (Figure 2), factors which ensure future growth. Additionally, this momentum is now less tied to traditional economics in the sense that the West attracts people not just because it grows jobs, but because more people now locate due to quality of life, landscape, recreation, etc. And just to put the icing on the West's demographic cake, the nation is on the verge of the largest retirement surge in its history, and the West enjoys a positive perception among retirees.

#### Land Use Trends

Perhaps the bigger story about population growth in the American West is that the land use 'footprint' of that population is enlarging *per capita* in the region. Here are some ways that works:

- More/Larger houses *per capita* (*more families per capita as of the 2000 census!*)
- Longer commutes ("extreme commuting")
- Enlarged commercial and infrastructure land uses *per capita*
- Inefficient regional land use (duplication)
- Further reach for resources like water & recreation into wildlands and onto public lands.

So, for example, during 1980-2000 *Colorado's population grew 49%, while urban/suburban land use grew 65%*. Additionally, it is my assessment that the changing geographic location of development in the West is such that it further complicates resources management and environmental protection. In particular, not only does the region host the fastest growing cities in the nation's absolutely driest environments, but expanding exurbs mean a growing impact on the edge of wildlands—leading to conflicts between development and species, wildfire, and other natural processes.

#### Resource Demand / Pressure on Land and Habitat

Partly because of the region's growing population and expanding economy, many of the West's resources are also under increasing pressure (though this, of course, is also fueled by national and international socio-economic trends, like the price of oil and the growth of international tourism). For example, simultaneously with another major energy rush, the West is also dramatically growing its recreational facilities: all the major, and many minor, ski resorts in the region are adding new facilities, expanding base villages and adding to

on-mountain facilities. Many are expanding their ski terrain, and one totally new major resort has opened in Idaho (Tamarack).

Despite efforts to protect roadless areas, the West's most natural landscapes are being whittled away, on public and private land, by the above forces, especially suburban and exurban sprawl on the latter, and energy development and the expansion of recreation on the former. A few counter-trends obtain. There's some evidence that we're in a transition in ranching in the West, where the grazing demand on public lands is waning and, in my view, likely to decline faster in the future. This does not necessarily mean an end to the federal range conflicts, which are driven as much by fees and some species regulations (especially for predators) as they are by environmental limits on grazing pressure, but new types of ranch owners, emerging conservation practices, and market pressures are yielding a different rangeland regime.

## **Resource Quality**

I am not an ecologist, but it does not take a biology degree to recognize that, despite some improvements (e.g., in water and air quality), most ecological assessments find mostly negative trends. Both the national (*State of the Nation's Ecosystems*, from the Heinz Center) and global (*Millennium Ecosystems Assessment*, from the UN) recent ecological assessments find mostly negative ecosystem trends, and I see no reason to dispute these trends in the West (though no western regional assessment has been made, to my knowledge). There is also little of a sanguine nature in projections of global warming impacts, nationally and in the American West (as indicated in Jerry Meehl and Chris Field's presentations/papers at the 2006 NRLC conference).

The science foundation for the threat of global warming is well established, and its regional manifestations are coming into better focus as actual trends and climate model output add to our understanding. The West will experience significant warming over the next century, and though Western precipitation projections vary, the warming effect on evapotranspiration and snowmelt assures the region an altered runoff regime; probably less total, but certainly earlier and more concentrated runoff in many key watersheds, trends that inevitably complicate water resources management. Even if precipitation does not decline in average, new information coming from the models and paleo-climatological studies indicate that the West will experience more frequent and more intense drought episodes over the next century. A real challenge in all climate-related trends is that shifts in mean conditions can be accompanied by significant changes in frequency and magnitude of extreme events.

Furthermore, a significant amount of warming through the middle of this century is already committed in the earth's climate system, even if the global community acts assiduously to reduce GHG emissions (and any delay simply worsens and prolongs the ultimate warming). The IPCC Fourth Assessment Report (IPCC AR4) Working Group 3 summary issued in Bangkok in May, suggests that with great effort we might be able to keep global warming to an additional 2 degrees C this century. I doubt it, and the West may warm more than 2 degrees even if the global average can be held to that threshold.

## **An Ill-fated Future?**

Dismal scenarios are easy to develop: Global warming and forest dynamics will conspire to create a couple of decades of much more widespread fires in the West (as occurred in the past record), but this recycling of the region's forests will occur when they are more involuted with development than ever before---this will be costly and painful episode, that will certainly force some policy changes.

While there is plenty of water in the West for urban growth, assuming it can and will move from agriculture, the resource is likely to become more unreliable such that urban supply systems will find themselves forced to do two unpleasant things: obtain larger supply compared to use in order to firm up reliability, and to declare more frequent shortages, and, eventually, permanent water rationing.

Land development and climate change, together, will stress habitat and species, such that conservation investments will become more risky, that is, the probability that any conservation plan will meet its objectives will decline. The general ecological notion is that systems undergoing stress tend to degrade, even as they attempt to adjust to new conditions. So the conservation problem is not just one of planning for change (e.g., protecting migration corridors, refugia, etc.), but of recognizing that some systems will degrade no matter what conservation plans are in place.

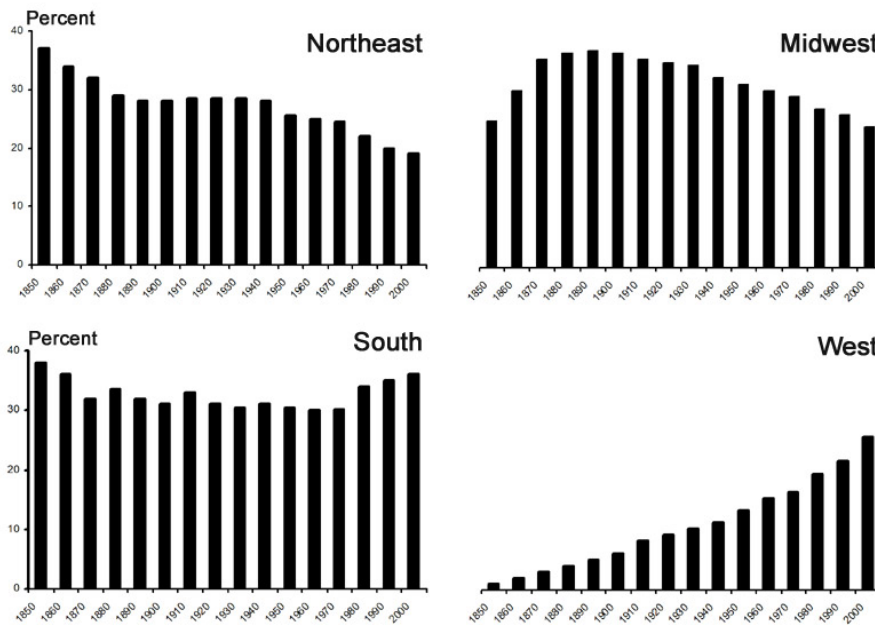


Figure 1: Proportion of total U.S. population in four quadrants, 1850-2000. Modified and up-dated from George Masnick, 2001: "America's shifting population: Understanding migration patterns across the West." *The Rocky Mountain West's Changing Landscape* 2(2) Winter/Spring: 8-14.





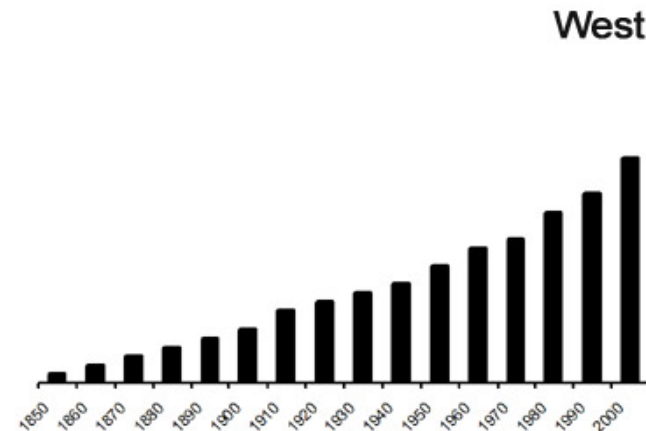
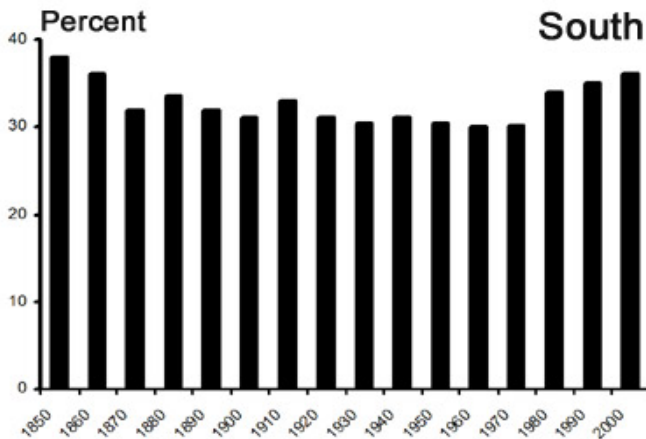
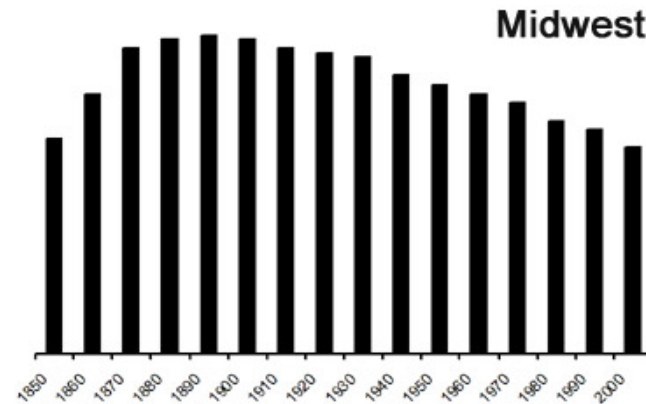
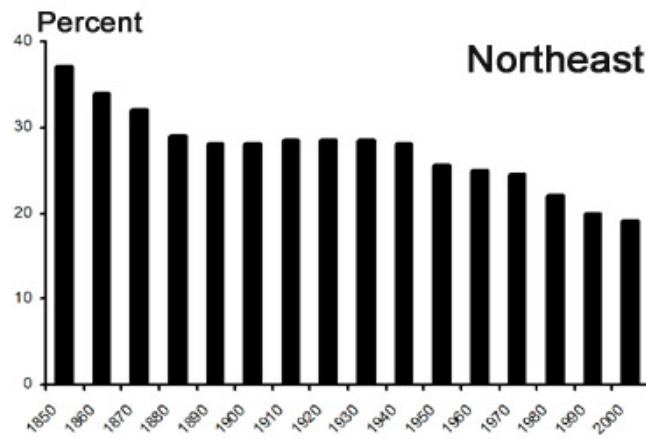
Socio-demographic trends

Land use trends

Climate change

# Growth in the American West

More “boom” than “bust”



# At least 28 million more by 2030.

	1990	2000	% growth 1990- 2000	Projected pop. 2030	% growth 2000- 2030	Total growth 2000-2030
Nevada	1,201,833	1,998,257	66	4,282,102	114	2,283,845
Arizona	3,665,228	5,130,632	40	10,712,397	109	5,581,765
Utah	1,722,850	2,233,169	30	3,485,367	56	1,252,198
Idaho	1,006,749	1,293,953	29	1,969,624	52	675,671
Wash	4,866,692	5,894,121	21	8,624,801	46	2,730,680
Oregon	2,842,321	3,421,399	20	4,833,918	41	1,412,519
Calif	29,760,021	33,871,648	14	46,444,861	37	12,573,213
Colorado	3,294,394	4,301,261	31	5,792,357	35	1,491,096
Montana	799,065	902,195	13	1,044,898	16	142,703
NMex	1,515,069	1,819,046	20	2,099,708	15	280,662
Wyo	453,588	493,782	9	522,979	6	29,197
TOTAL	51,127,810	61,359,463	20	89,813,012	46	28,453,549

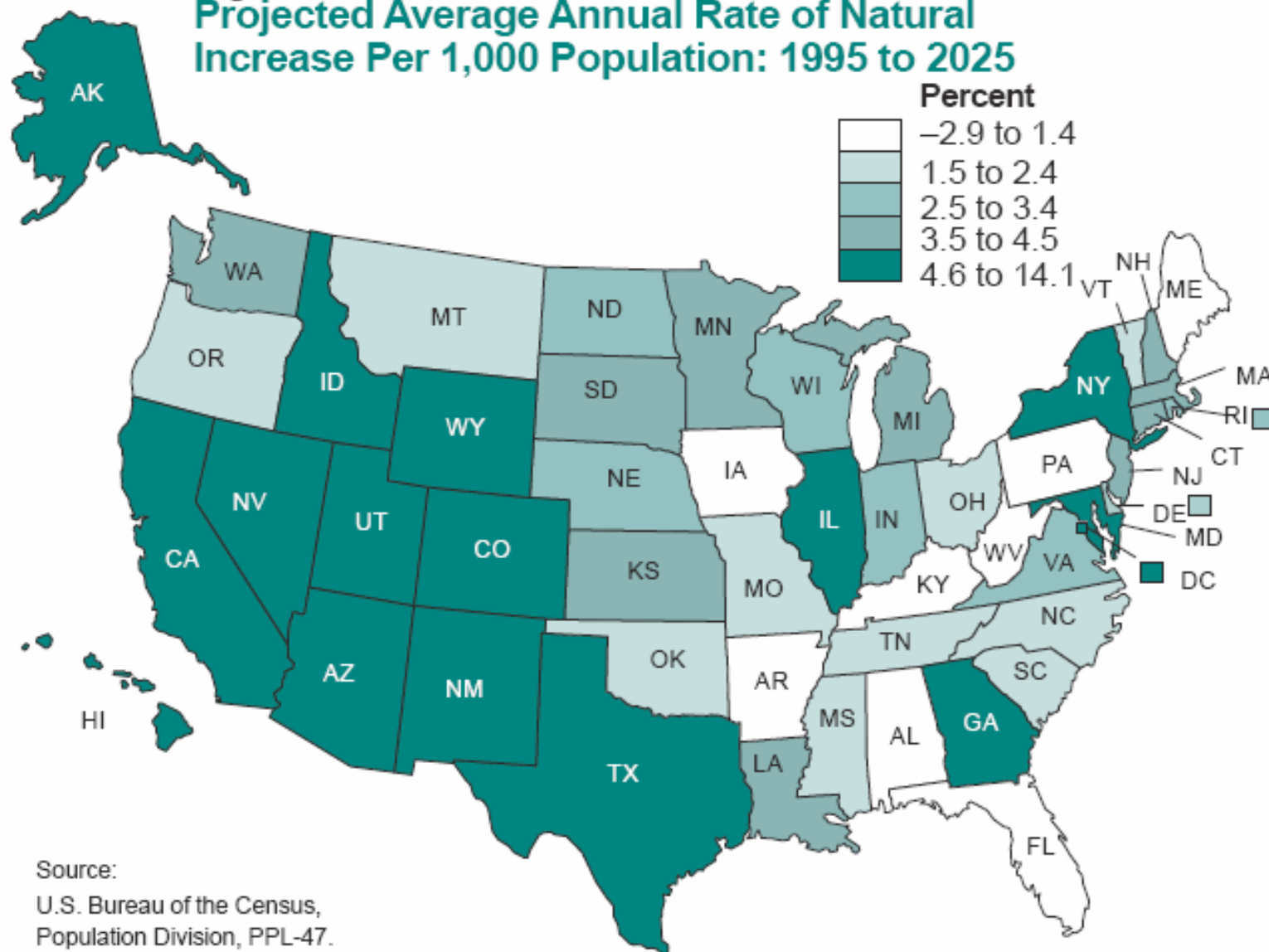
29%



# Continued Population Growth

- + Natural increase (high fertility)
- + Domestic migration (attractive place to live, w/ significant job growth)
- + International immigration (documented and undocumented)

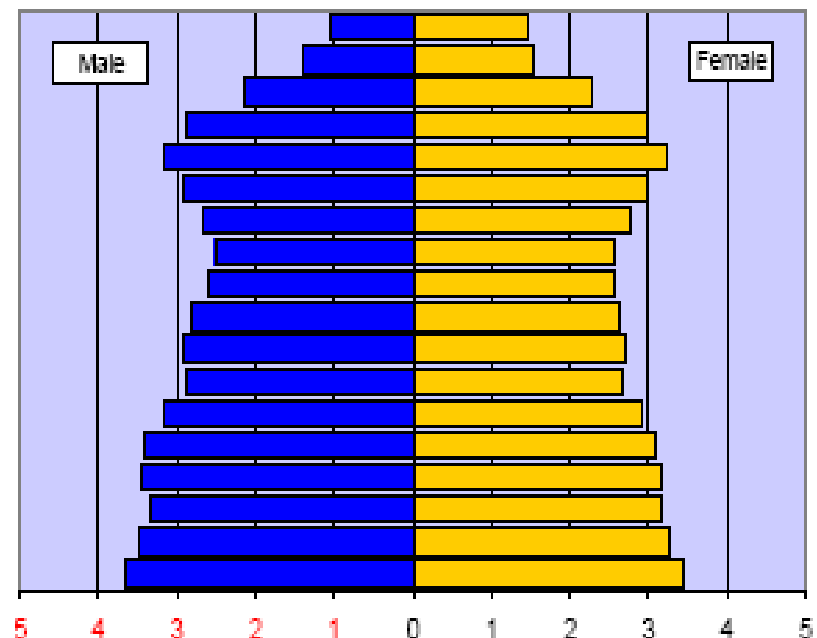
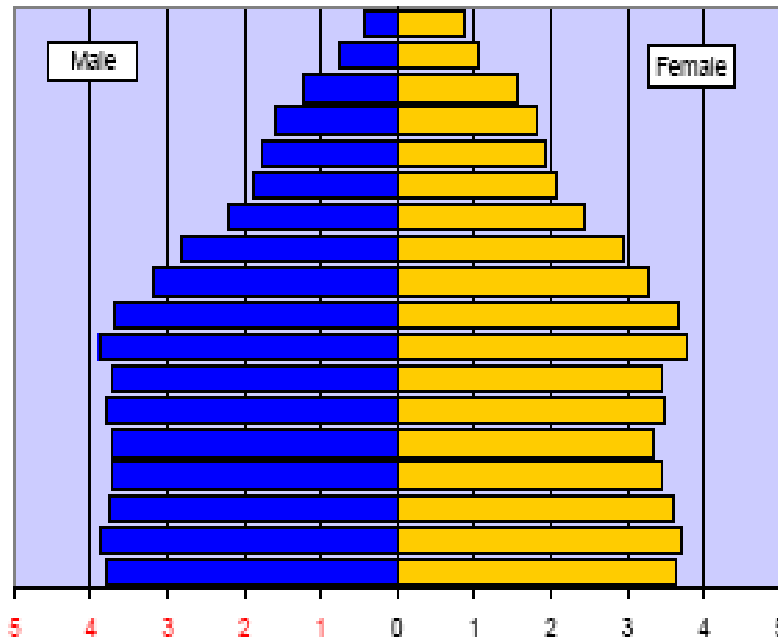
Figure 3.  
**Projected Average Annual Rate of Natural  
 Increase Per 1,000 Population: 1995 to 2025**



# Arizona

2000

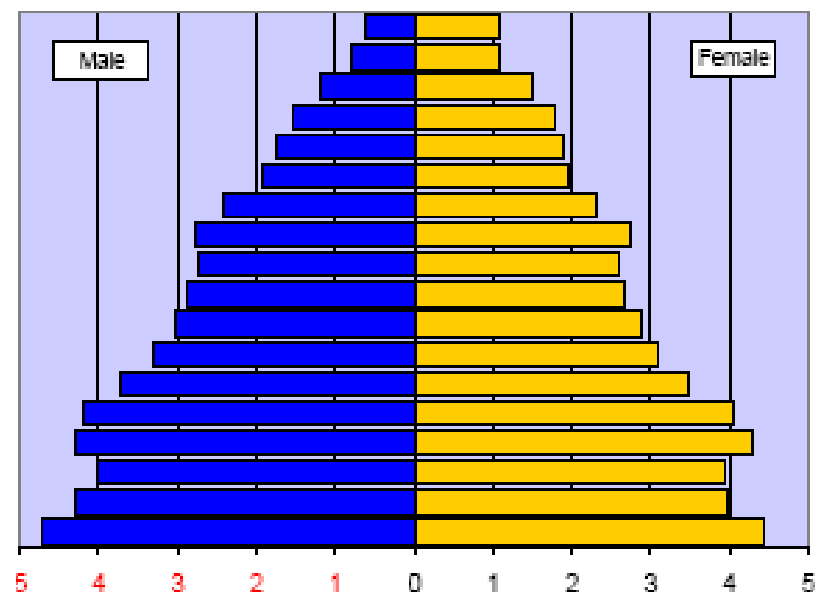
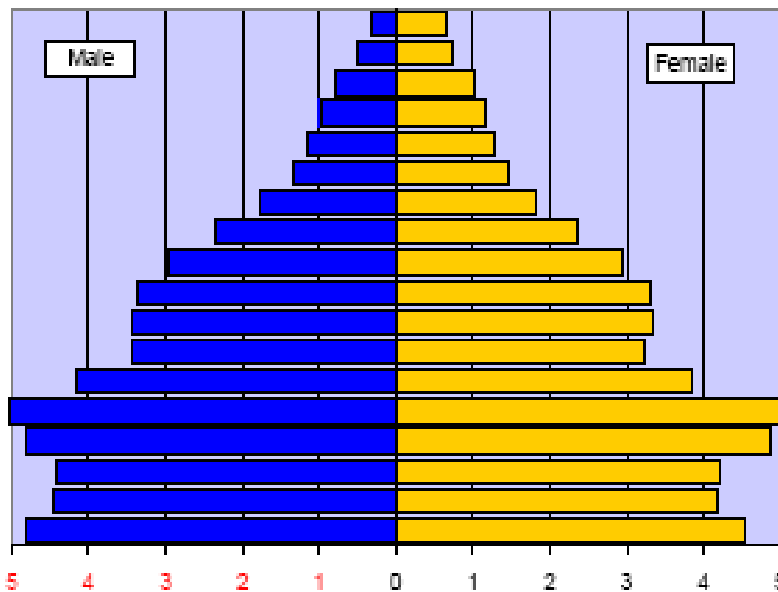
2030

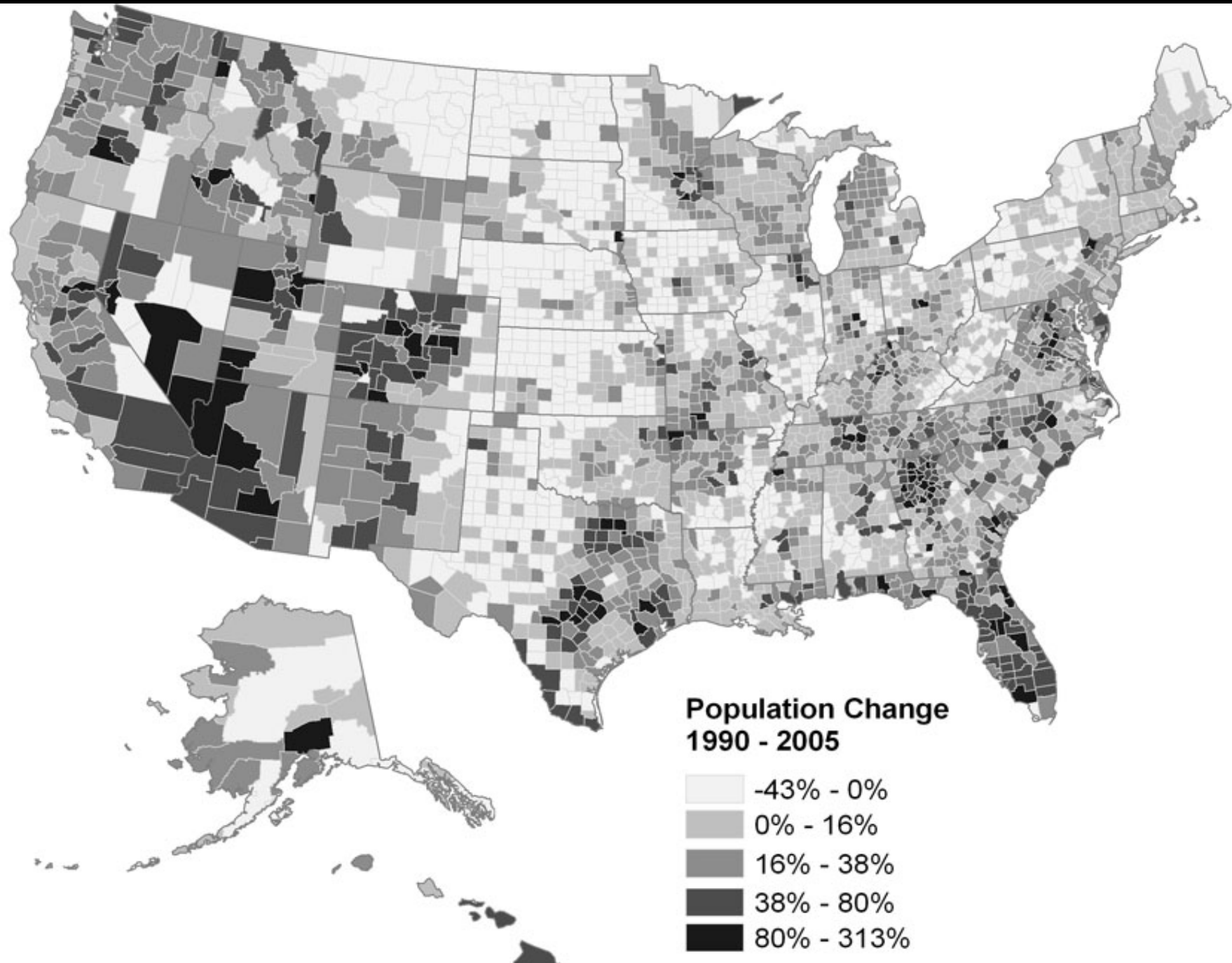


# Utah

2000

2030





# Footprint of Development

*enlarging per capita*

*e.g., 1980-2000 Colorado Pop grew 49%  
but urban/suburban land use grew 65%.*

- **More/Larger houses *per capita* (more families *per capita*!)**
- **Enlarged commercial and infrastructure land uses**
- **Inefficient regional land use**
- **Exurbanization and longer commutes (“extreme commuting”)**
- **More development & people in the wildland interface**
- **Further reach for resources like water & recreation into wildlands and onto public lands.**

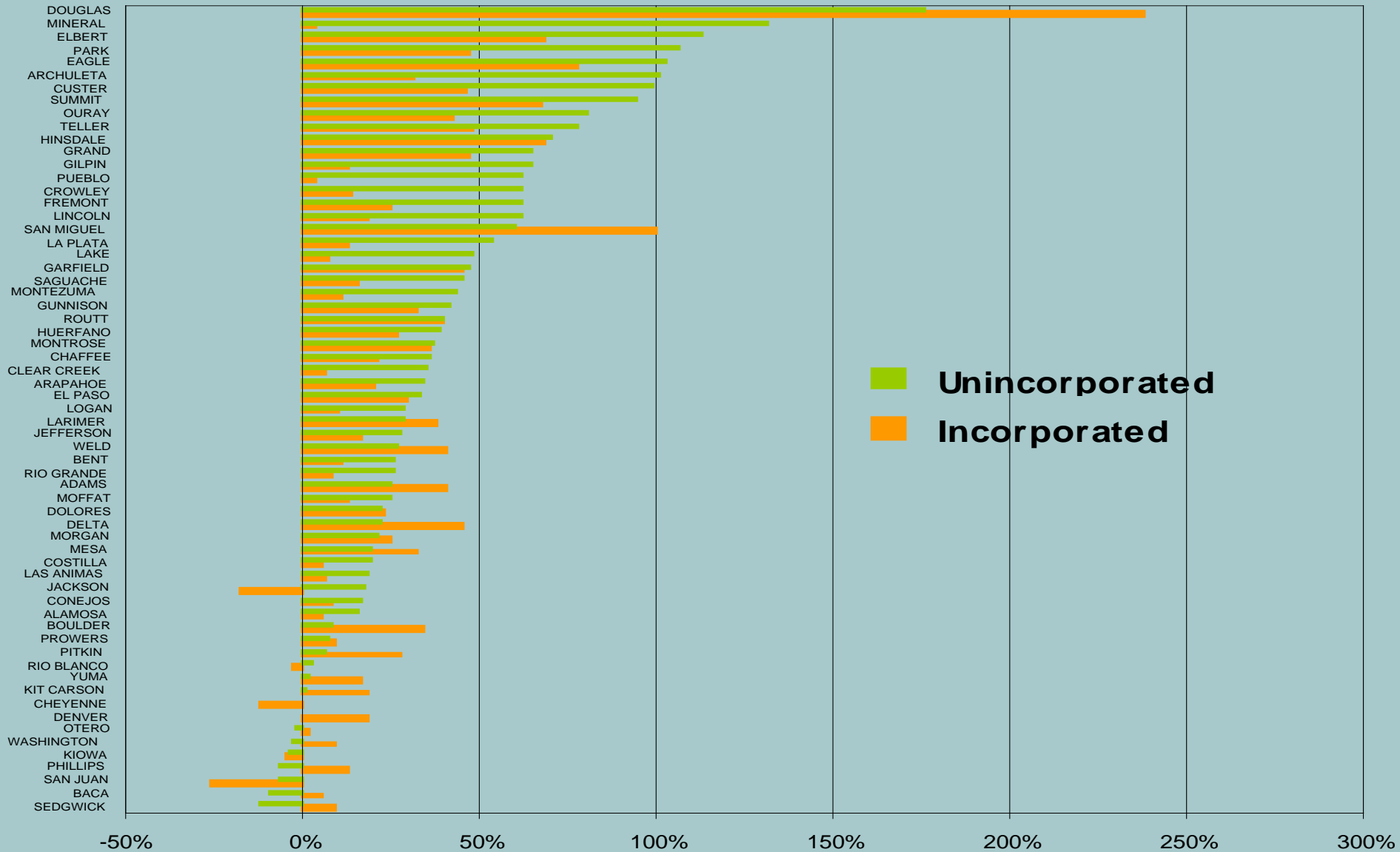


# Exurban Development



*Realm of the “Extreme Commute”*

# Colorado Growth by County 1990-00









**Up against  
the federal  
lands.**



**Into the  
forest  
fringe.**



0 600 1,200 2,400 Feet

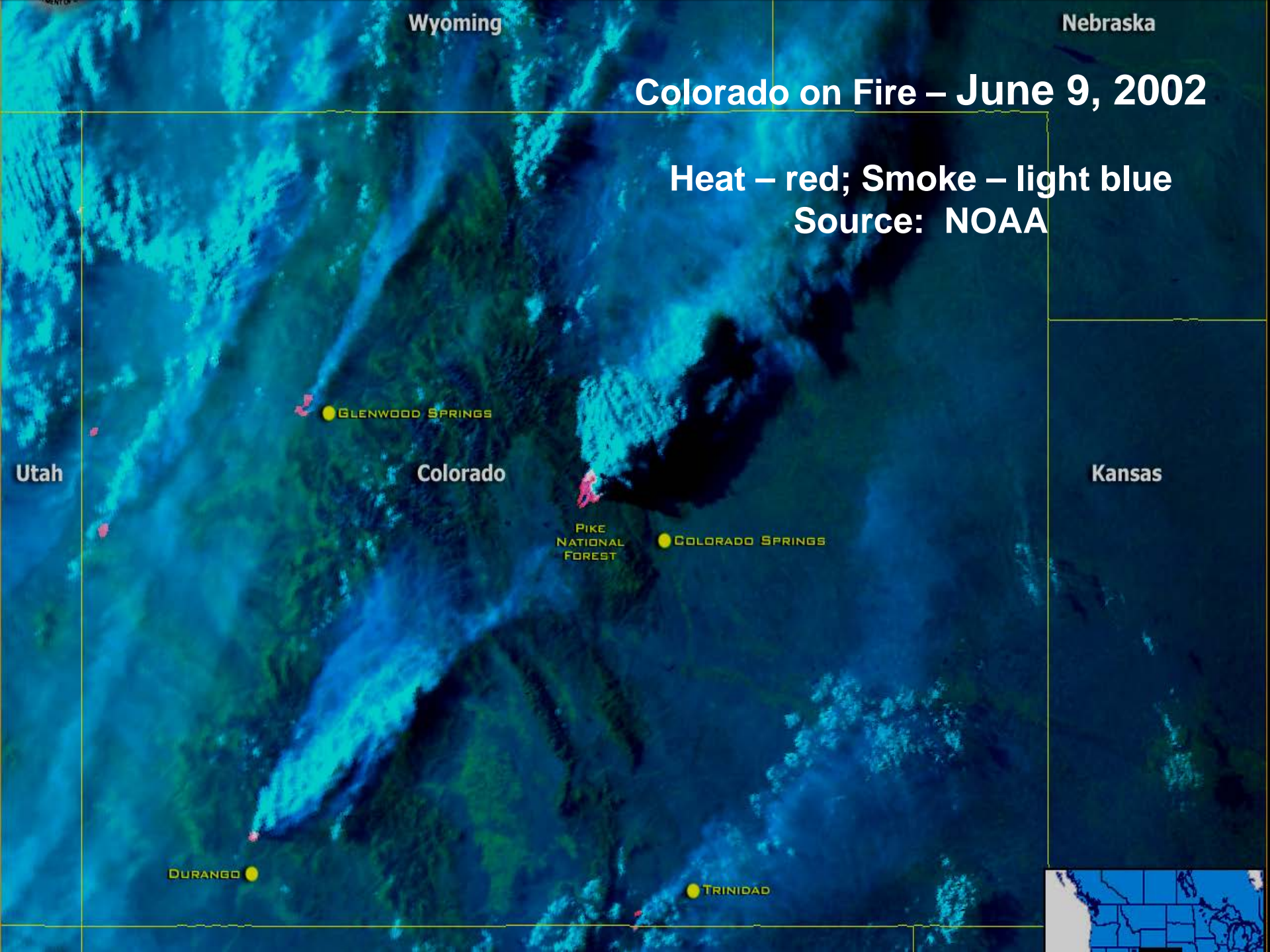


Wyoming

Nebraska

# Colorado on Fire – June 9, 2002

Heat – red; Smoke – light blue  
Source: NOAA



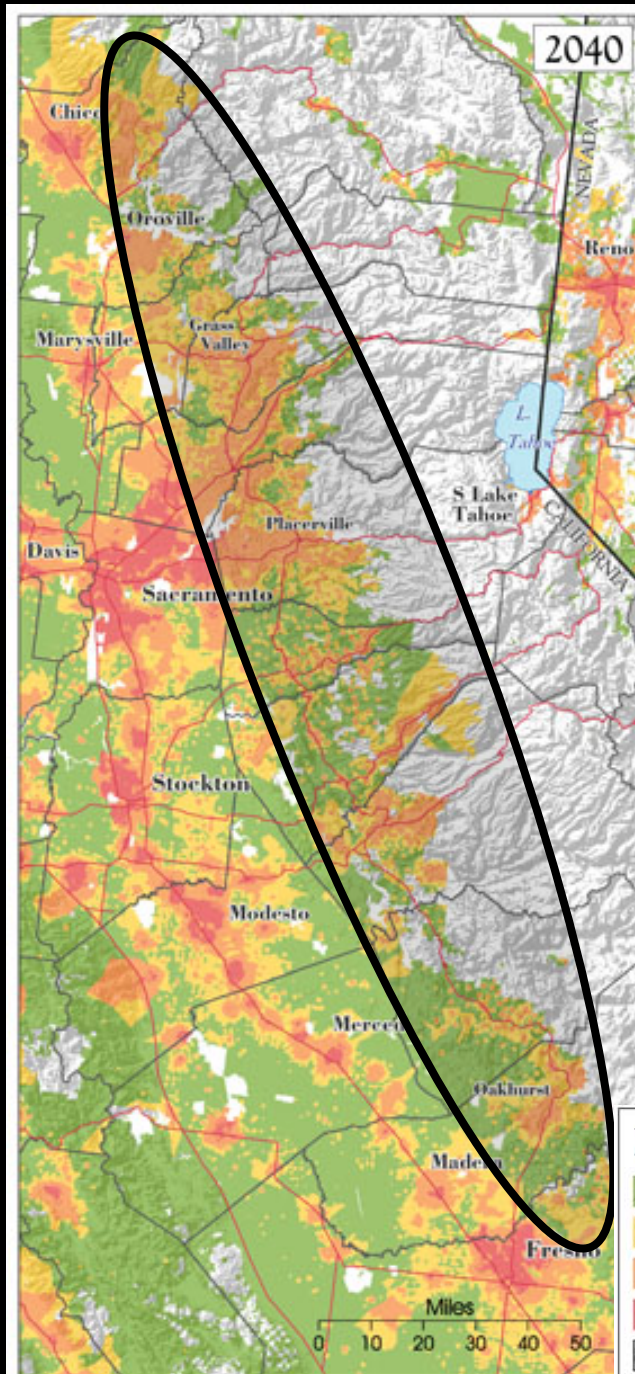
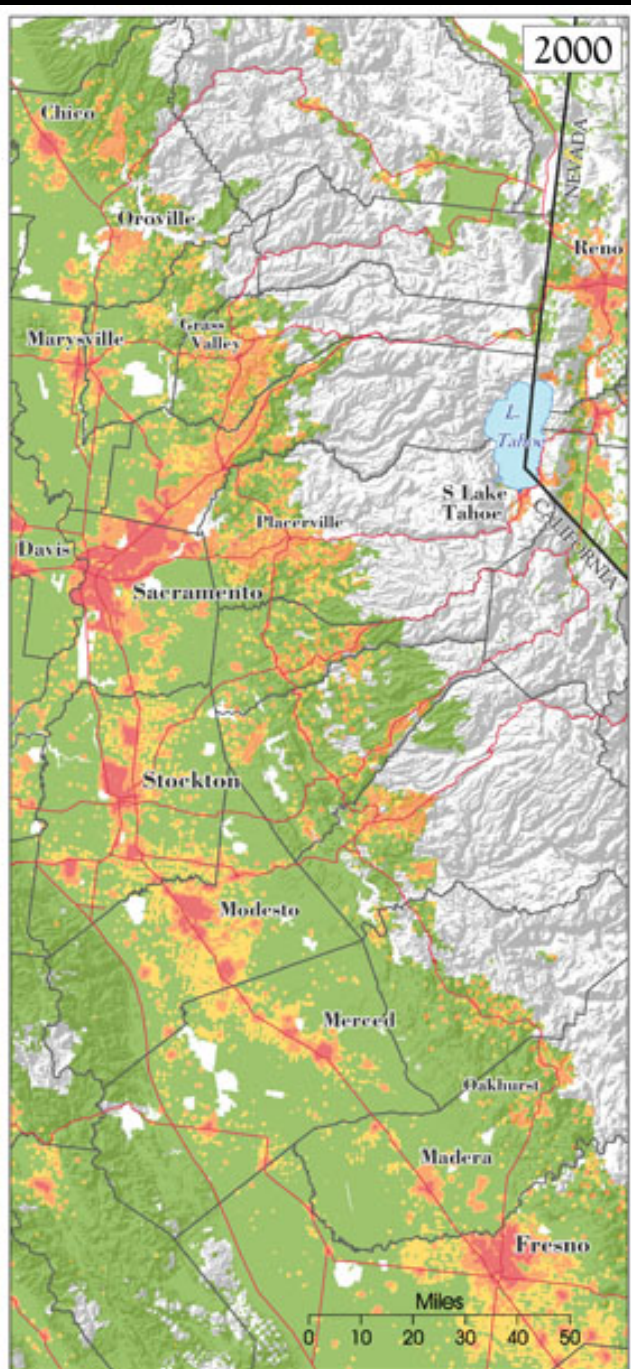












**Extensive  
exurbanizing  
zones---this  
case in  
Sierra  
Foothills,  
2040.**

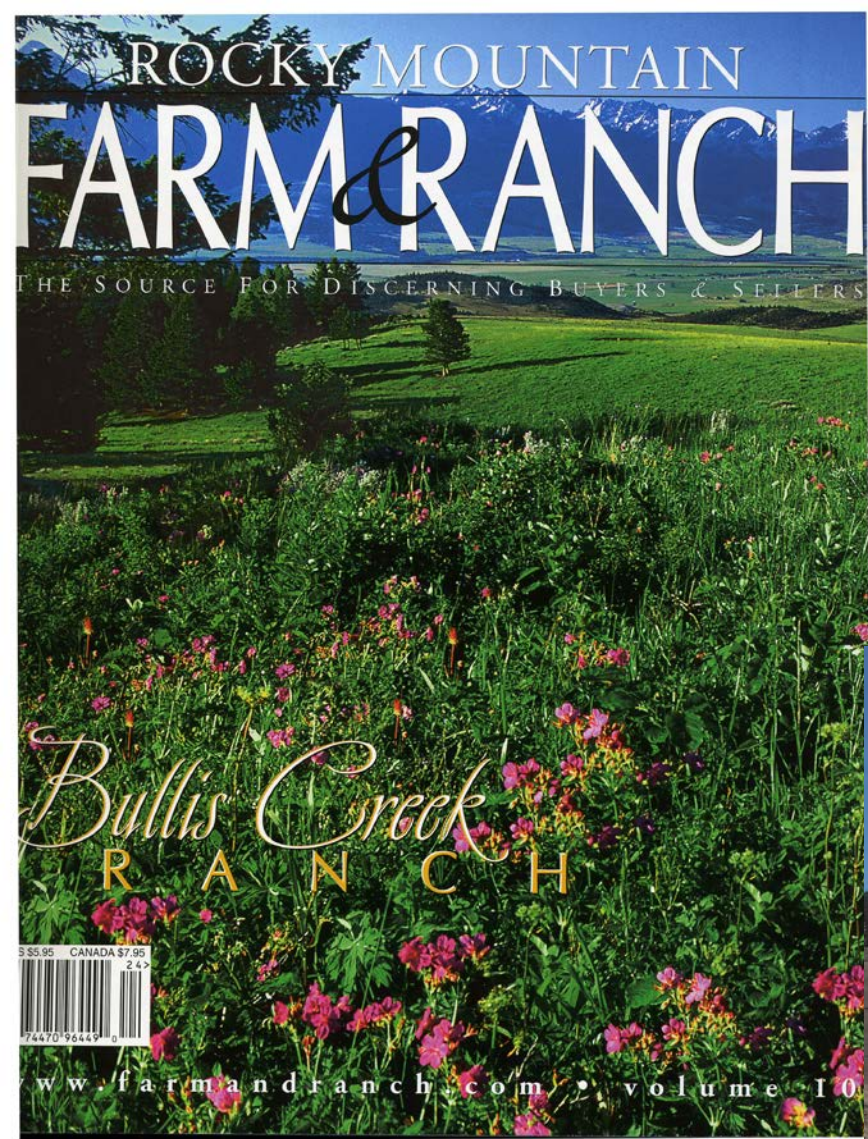
#### Land Use Categories

- Rural (<1 unit per 40 acres)
- Exurban (1 unit per 10 to 40 acres)
- Low Density Suburban (1 unit per 0.5 to 10 acres)
- Urban/Suburban (>2 units per acre)
- Not Buildable

# Ranchland Ownership Change



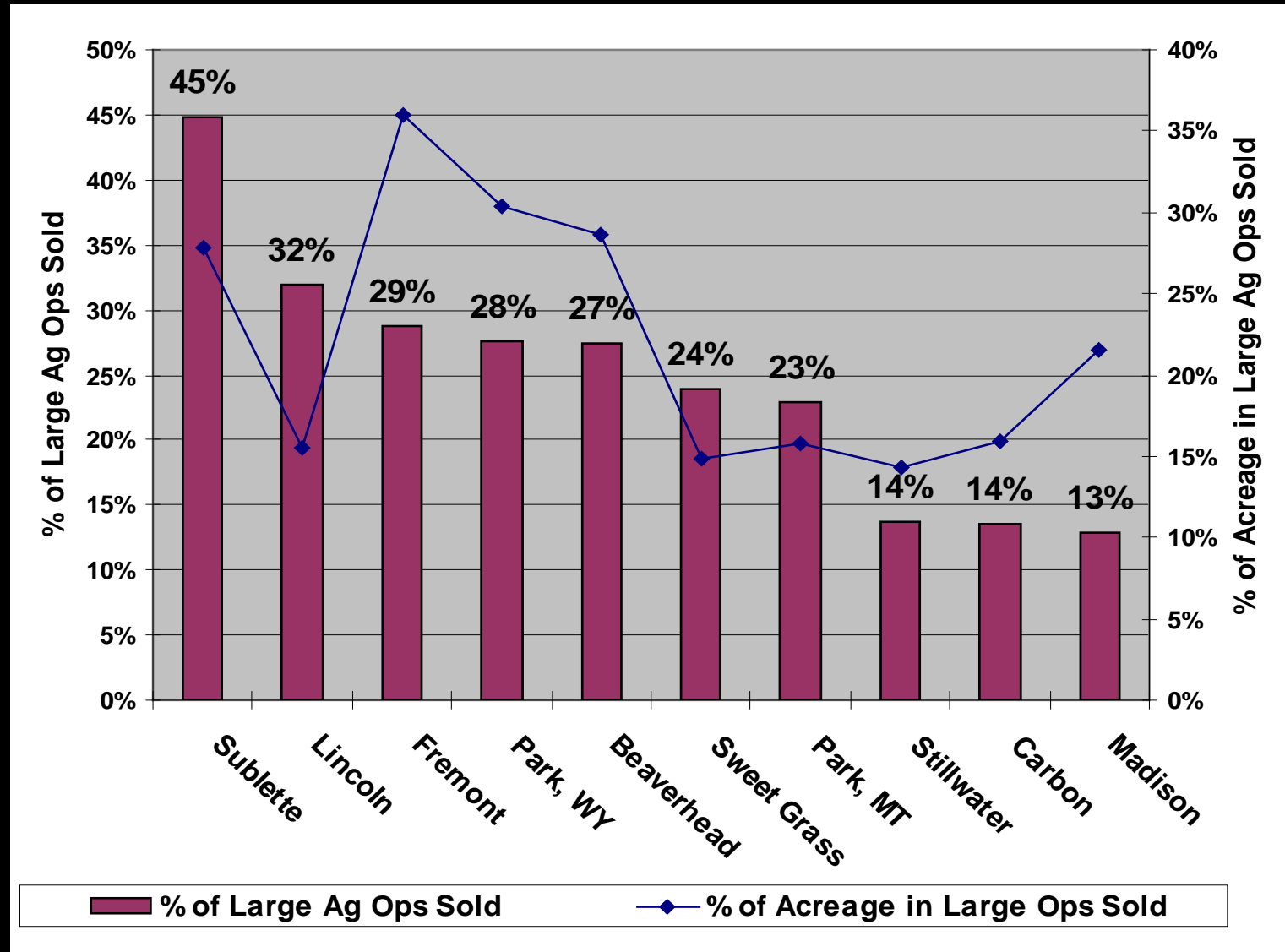


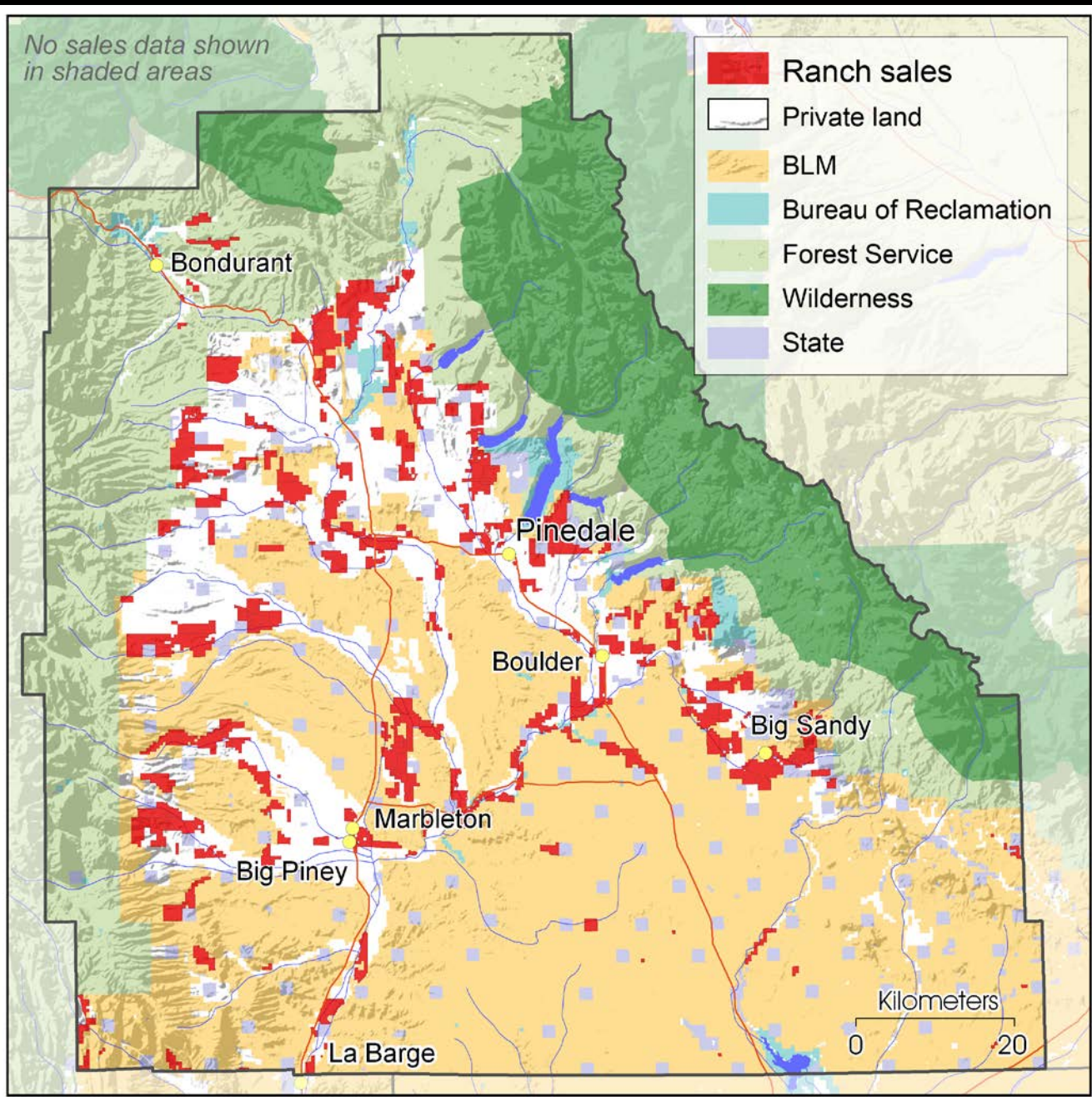




# Large Ranch Sales as Percentage of All Large Ranches

## GYE Ranchlands Study Counties, 1990-2001





Existing  
Ranch  
Management

SALE

Maintain Existing  
Management

Superficial Change  
in Management

- Investment Orientation
- Restore, repaint, rest

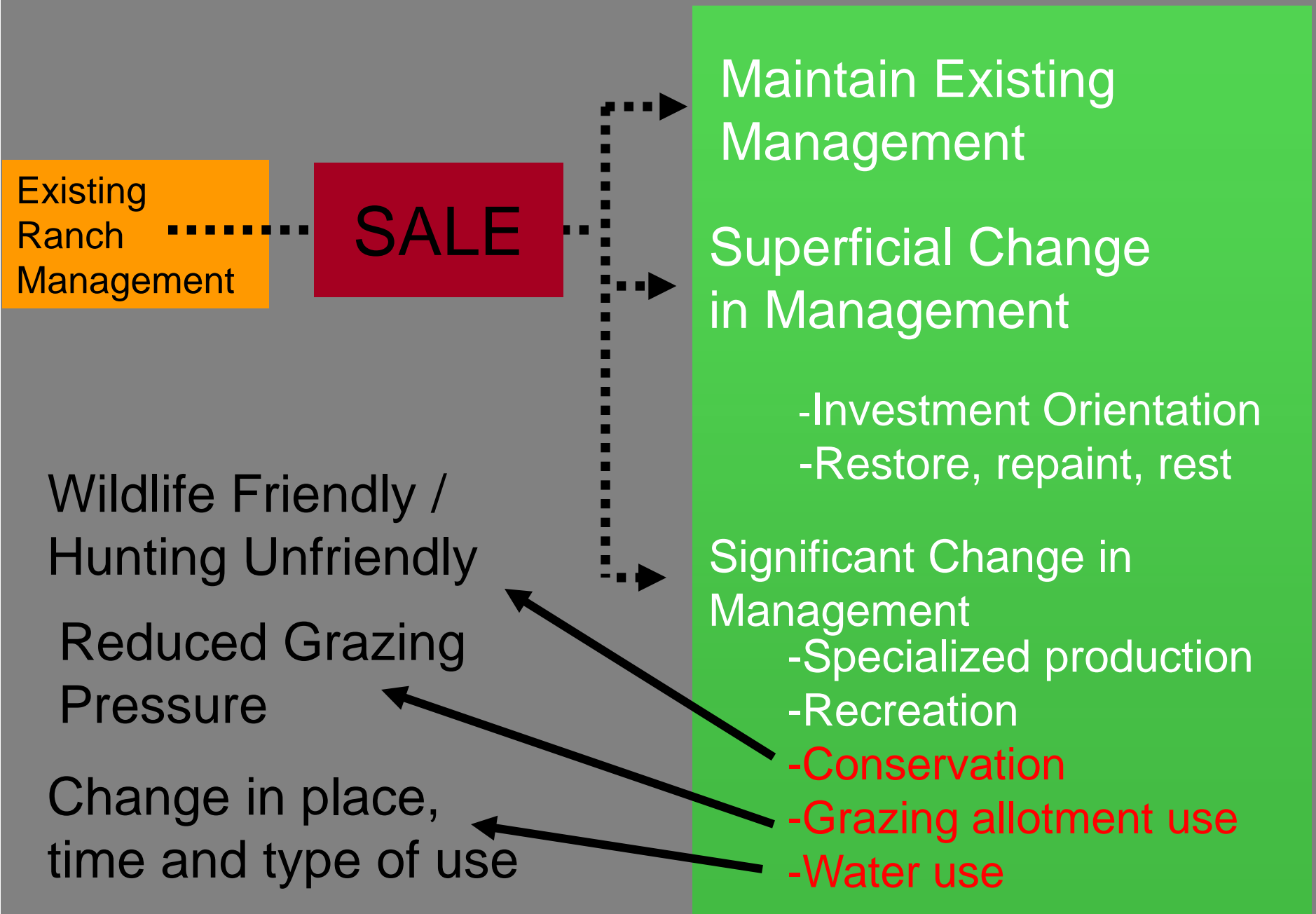
Significant Change in  
Management

- Specialized production
- Recreation
- Conservation
- Grazing allotment use
- Water use

Wildlife Friendly /  
Hunting Unfriendly

Reduced Grazing  
Pressure

Change in place,  
time and type of use





- ***NEW LISTING!***

Canyon Ranch, Beaverhead County. The 1,270 acre Canyon Ranch represents an unusual opportunity to acquire 3 +/- miles of one of the finer spring creek fisheries in the west. The structural compound is well built, technologically advanced and comfortable for accommodating a single owner or a multitude of guests. With four miles of improved horse trails, miles of fishing, a world class trout lake and abundant wildlife, this is a recreational treasure ***complimented by a working cattle operation.*** Settled in a very scenic canyon adjacent to vast federal ground, the ranch is positioned in a relatively undiscovered part of western





## Mountain Ranch

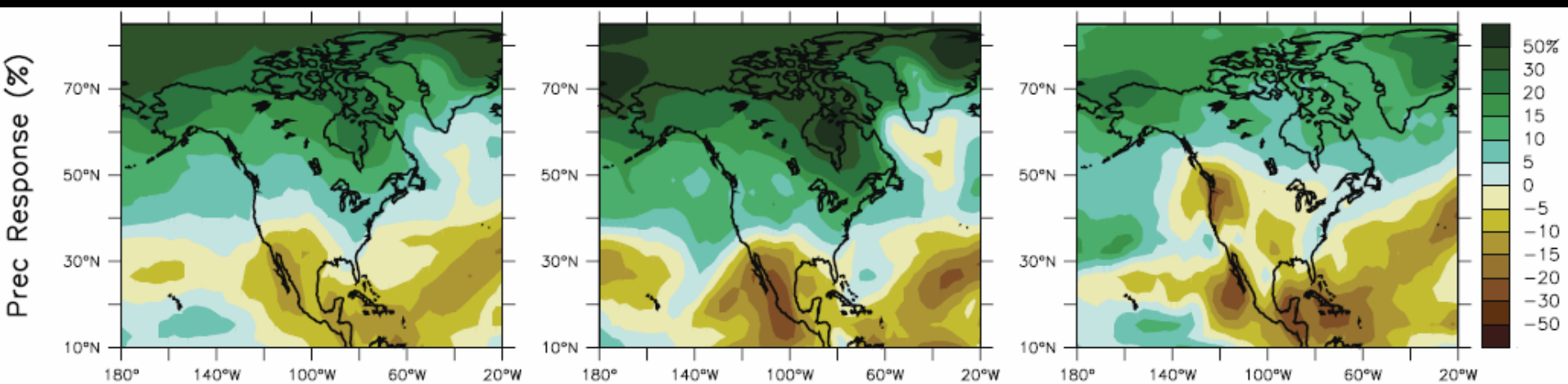
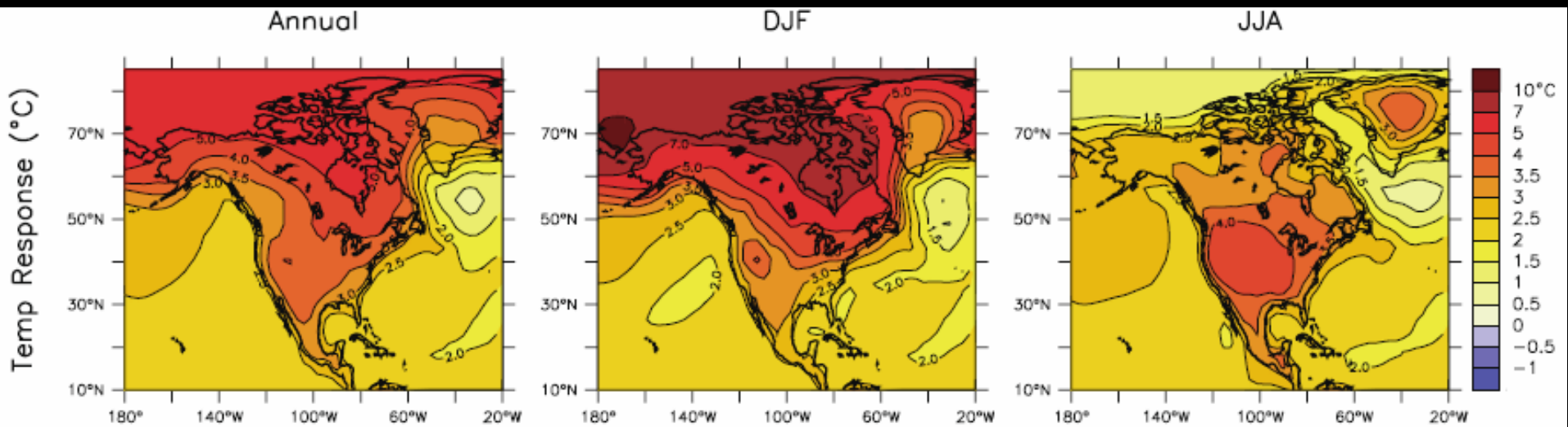
Wyoming ♦ Albany County ♦ Garrett

In the Laramie Mountains, with two large lakes, many reservoirs, live water and springs, scattered with pine and cedar trees, this 12,240±-deeded-acre high mountain ranch has 840 BLM and 640 state-lease acres. It features many streams and irrigated meadows, functional cattle working facilities and a complete set of improvements.

Wildlife includes mule deer, antelope, elk, bighorn sheep, upland game, waterfowl, fish, coyote, bobcat, bear and mountain lion. \$4,400,000.









## Less snow, more heat

The latest report from the Inter-governmental Panel on Climate Change says global warming could cause a 7 to 8 degree Fahrenheit

increase in the average Colorado temperatures by 2100. Some of the climate models used in the report indicate there will be little or no

increase in precipitation over the century. The end result is likely to be a drier Colorado, which has many implications.

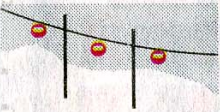
### Possible effect



#### Reduction in snowpack

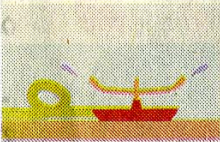
### What does it mean?

■ Snowpacks provide most of the region's water. As temperatures rise, more autumn and spring precipitation will fall as rain rather than snow. Spring melting would start earlier.



#### Shorter ski season

■ Colorado's \$2 billion ski industry could suffer from a shorter season. The season would be squeezed on both ends, fall and spring, and attempts to make up for a natural snow deficit with man-made snow could fall short because of warmer temperatures.



#### Earlier peak runoff and lower summer flows

■ As the snowpack melts sooner, winter and early spring floods could become more common. But later in the year, less water would be available to irrigate farms and water lawns.



#### Longer heat waves

■ Could last two days longer than they do now, and the number of heat waves per summer could double by the end of the century. In the Denver area, climate warming could lead to nighttime lows that are 3 to 4 degrees higher during summer heat waves.



#### Longer growing season

■ The length of the growing season could increase significantly across the West, a benefit if there is enough water to irrigate crops.

**WEB SITES WITH MORE INFORMATION** IPCC report: [www.ipcc.ch](http://www.ipcc.ch); general climate: [www.noaa.gov](http://www.noaa.gov) and [www.ucar.edu](http://www.ucar.edu)

Sources: Rocky Mountain/Great Basin Regional Climate-Change Assessment, Climate Change Impacts on the United States, National Center for Atmospheric Research

JOHN SOPINSKI/ROCKY MOUNTAIN NEWS



## Regional Climate Projections

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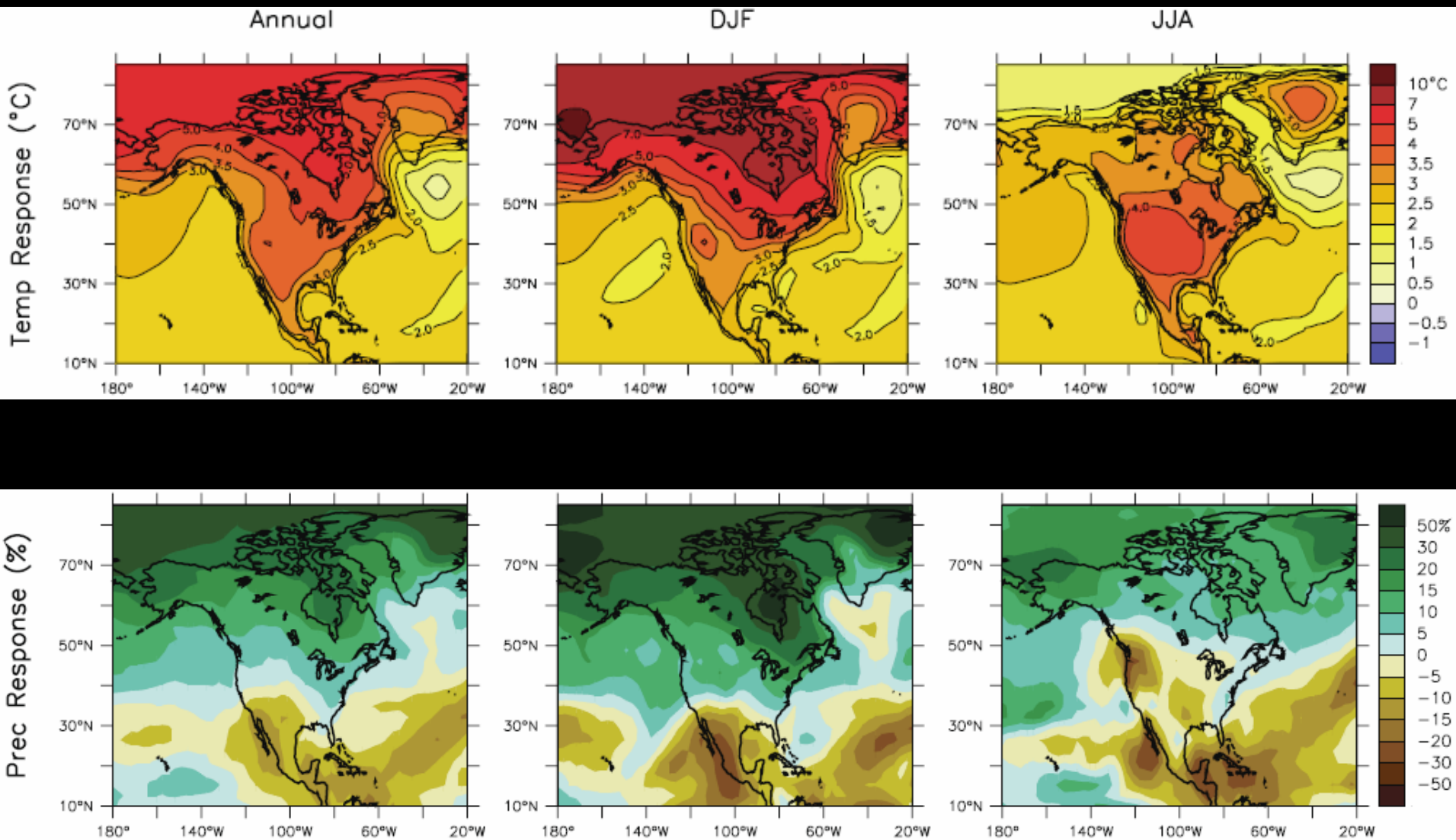
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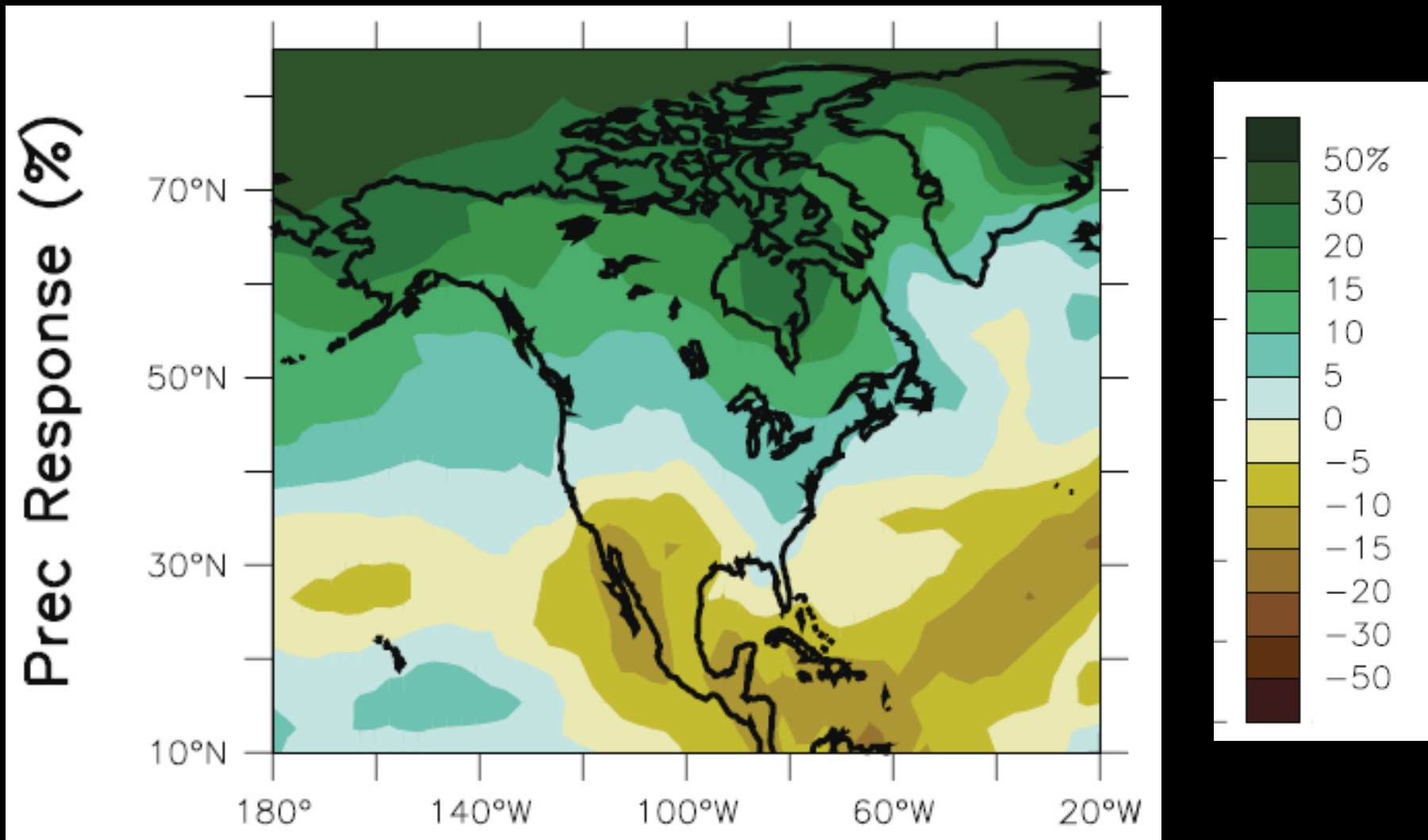
Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007: Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.





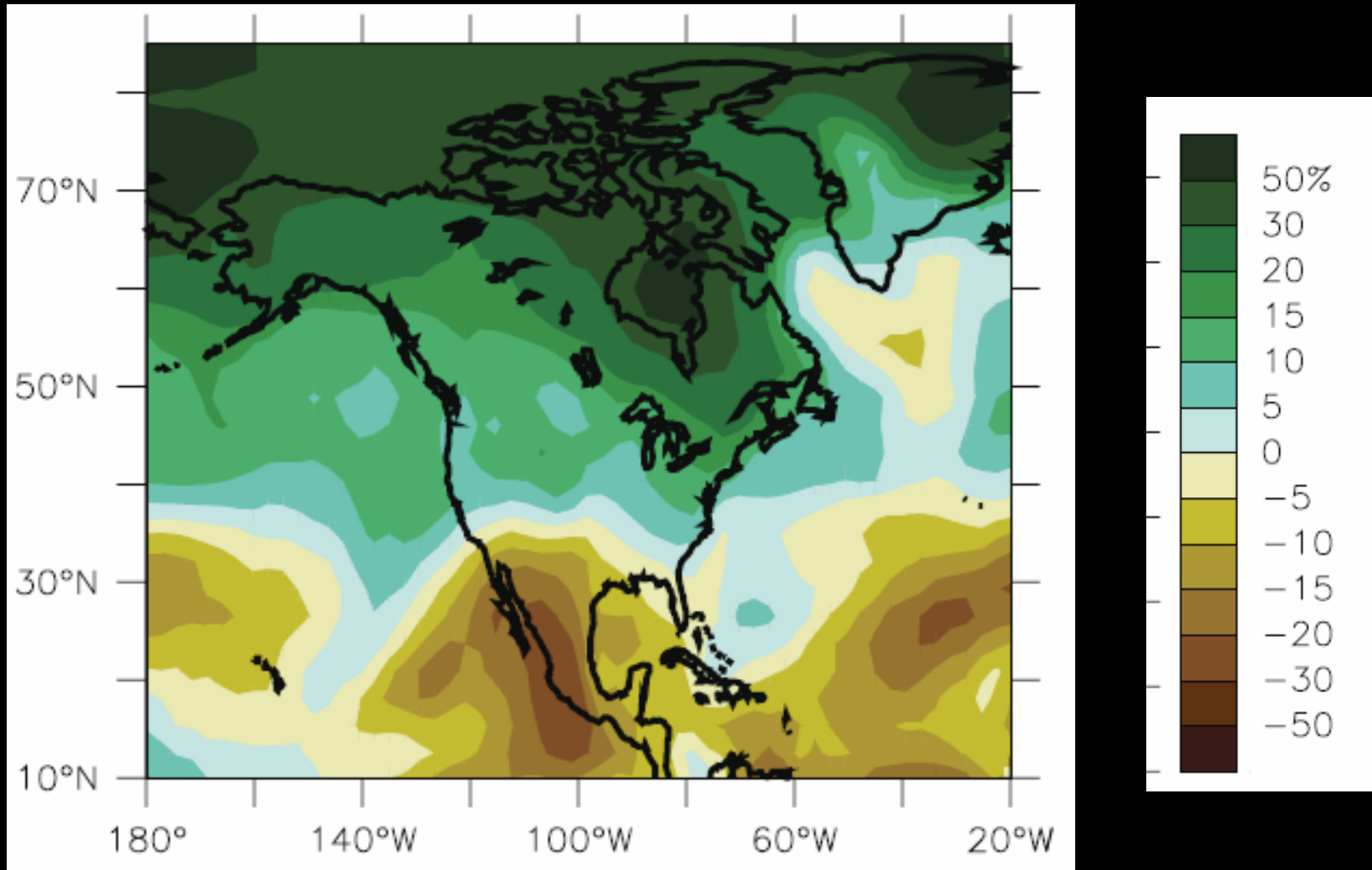
Change between 1980-1999 and 2080-2099 for A1B scenario averaged over 21 models

# Annual Precipitation Change



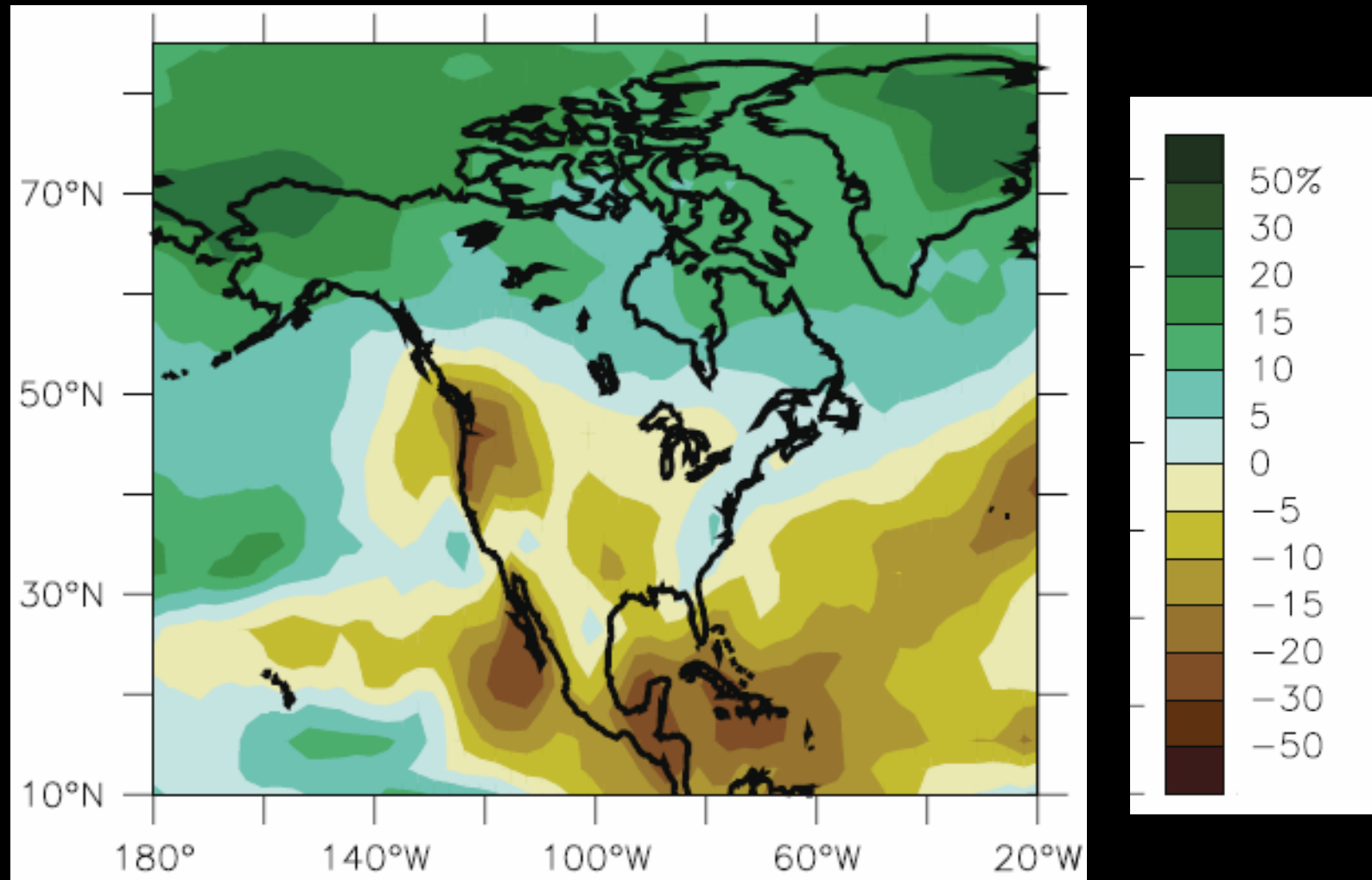
Change between 1980-1999 and 2080-2099 for A1B scenario averaged over 21 models

# Winter (DJF) Precipitation Change



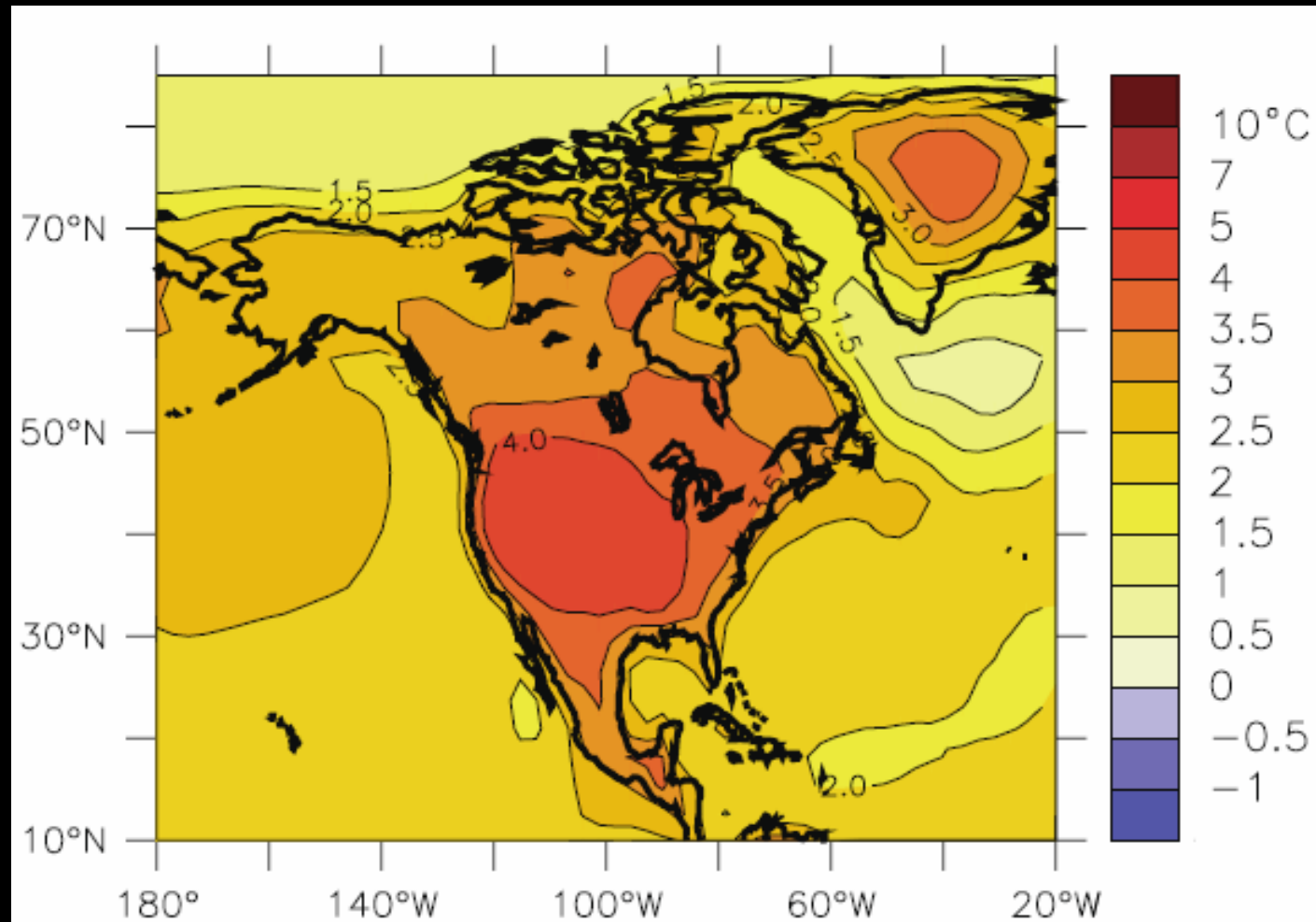
Change between 1980-1999 and 2080-2099 for A1B scenario averaged over 21 models

# Summer (JJA) Precipitation Change



Change between 1980-1999 and 2080-2099 for A1B scenario averaged over 21 models

# Summer (JJA) Temperature Change



Change between 1980-1999 and 2080-2099 for A1B scenario averaged over 21 models



# Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity

A. L. Westerling,<sup>1,2\*</sup> H. G. Hidalgo,<sup>1</sup> D. R. Cayan,<sup>1,3</sup> T. W. Swetnam<sup>4</sup>

Western United States forest wildfire activity is widely thought to have increased in recent decades, yet neither the extent of recent changes nor the degree to which climate may be driving regional changes in wildfire has been systematically documented. Much of the public and scientific discussion of changes in western United States wildfire has focused instead on the effects of 19th- and 20th-century land-use history. We compiled a comprehensive database of large wildfires in western United States forests since 1970 and compared it with hydroclimatic and land-surface data. Here, we show that large wildfire activity increased suddenly and markedly in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. The greatest increases occurred in mid-elevation, Northern Rockies forests, where land-use histories have relatively little effect on fire risks and are strongly associated with increased spring and summer temperatures and an earlier spring snowmelt.

**W**ildfires have consumed increasing areas of western U.S. forests in recent years, and fire-fighting expenditures by federal land-management agencies now regularly exceed US\$1 billion/year (1). Hundreds of homes are burned annually by wildfires, and damages to natural resources are sometimes extreme and irreversible. Media reports of recent, very large wildfires (>100,000 ha) burning in western forests have garnered widespread public attention, and a recurrent

34 years of western U.S. (hereafter, "western") wildfire history together with hydroclimatic data to determine where the largest increases in wildfire have occurred and to evaluate how recent climatic trends may have been important causal factors.

**Competing explanations: Climate versus management.** Land-use explanations for increased western wildfire note that extensive livestock grazing and increasingly effective fire suppression began in the late 19th and early

In contrast, climatic explanations posit that increasing variability in moisture conditions (wet/dry oscillations promoting biomass growth, then burning), and/or a trend of increasing drought frequency, and/or warming temperatures have led to increased wildfire activity (13, 14). Documentary records and proxy reconstructions (primarily from tree rings) of fire history and climate provide evidence that western forest wildfire risks are strongly positively associated with drought concurrent with the summer fire season and (particularly in ponderosa pine-dominant forests) positively associated to a lesser extent with moist conditions in antecedent years (13–18). Variability in western climate related to the Pacific Decadal Oscillation and intense El Niño/La Niña events in recent decades along with severe droughts in 2000 and 2002 may have promoted greater forest wildfire risks in areas such as the Southwest, where precipitation anomalies are significantly influenced by patterns in Pacific sea surface temperature (19–22). Although corresponding decadal-scale variations and trends in climate and wildfire have been identified in paleo studies, there is a paucity of evidence for such associations in the 20th century.

We describe land-use history versus climate as competing explanations, but they may be complementary in some ways. In some forest types, past land uses have probably increased the

## Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America

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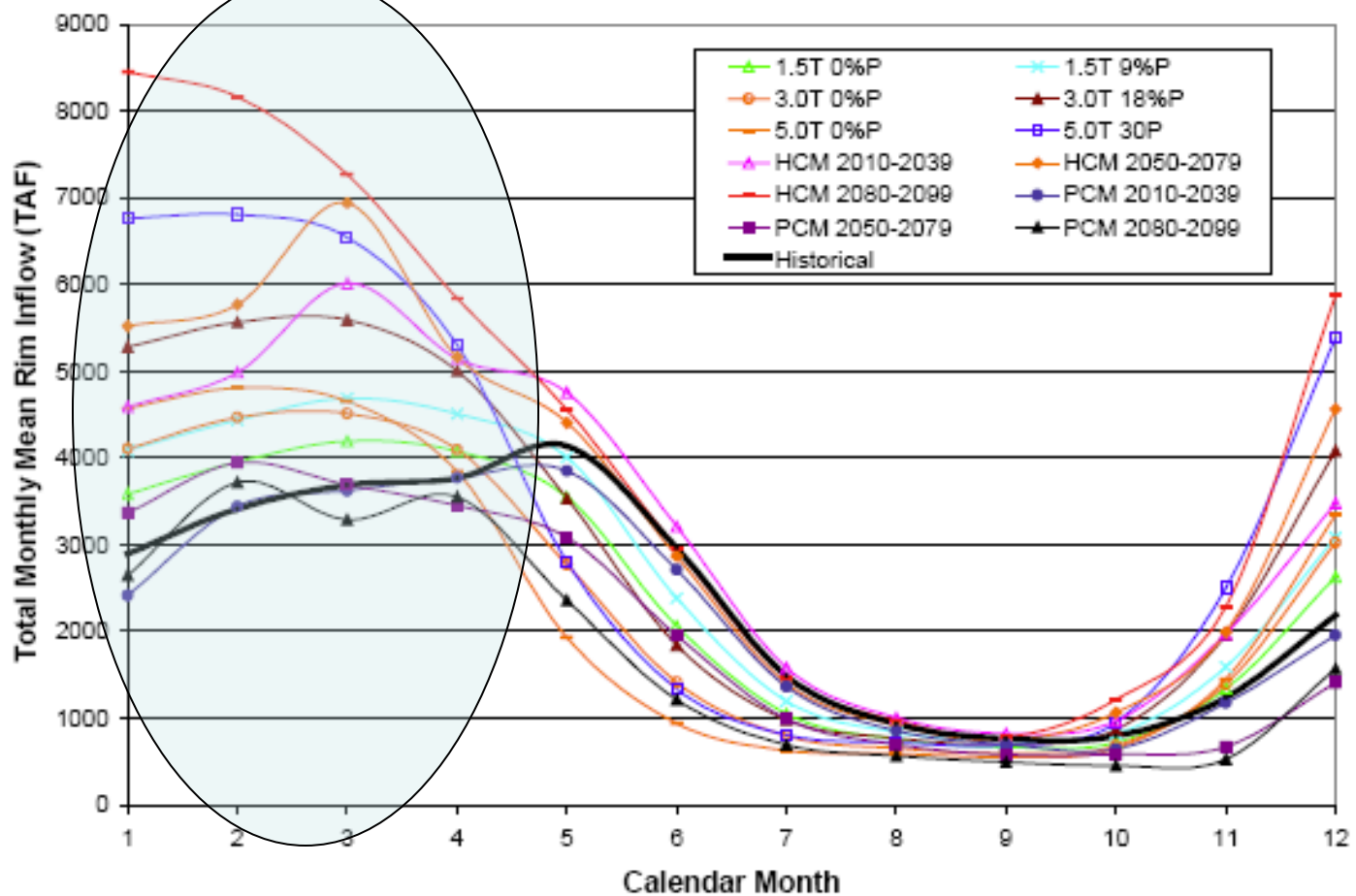
<sup>1</sup>Lamont Doherty Earth Observatory of Columbia University, Palisades, NY, USA. <sup>2</sup>NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ, USA. <sup>3</sup>Program in Atmospheric and Oceanic Sciences, Department of Geosciences, Princeton University, Princeton, NJ, USA. <sup>4</sup>National Center for Atmospheric Research, Boulder, CO, USA. <sup>5</sup>Tel Aviv University, Tel Aviv, Israel.

**How anthropogenic climate change will impact hydroclimate in the arid regions of Southwestern North America has implications for the allocation of water resources and the course of regional development. Here we show that there is a broad consensus amongst climate models that this region will dry significantly in the 21st century and that the transition to a more arid climate should already be underway. If these models are correct, the levels of aridity of the recent multiyear drought, or the Dust Bowl and 1950s droughts, will, within the coming years to decades, become the new climatology of the American Southwest.**

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) reported that the average of all the

States and parts of northern Mexico. Fig. 1 shows the modeled history and future of the annual mean precipitation minus evaporation ( $P-E$ ) averaged over this region for the period common to all the models, 1900–2098. The median, 25th and 75th percentiles of the model  $P-E$  distribution and the median of  $P$  and  $E$  are shown. For cases in which there were multiple simulations with a single model these were averaged together before computing the distribution.  $P-E$  equals the moisture convergence by the atmospheric flow and, over land, the amount of water that goes into runoff.

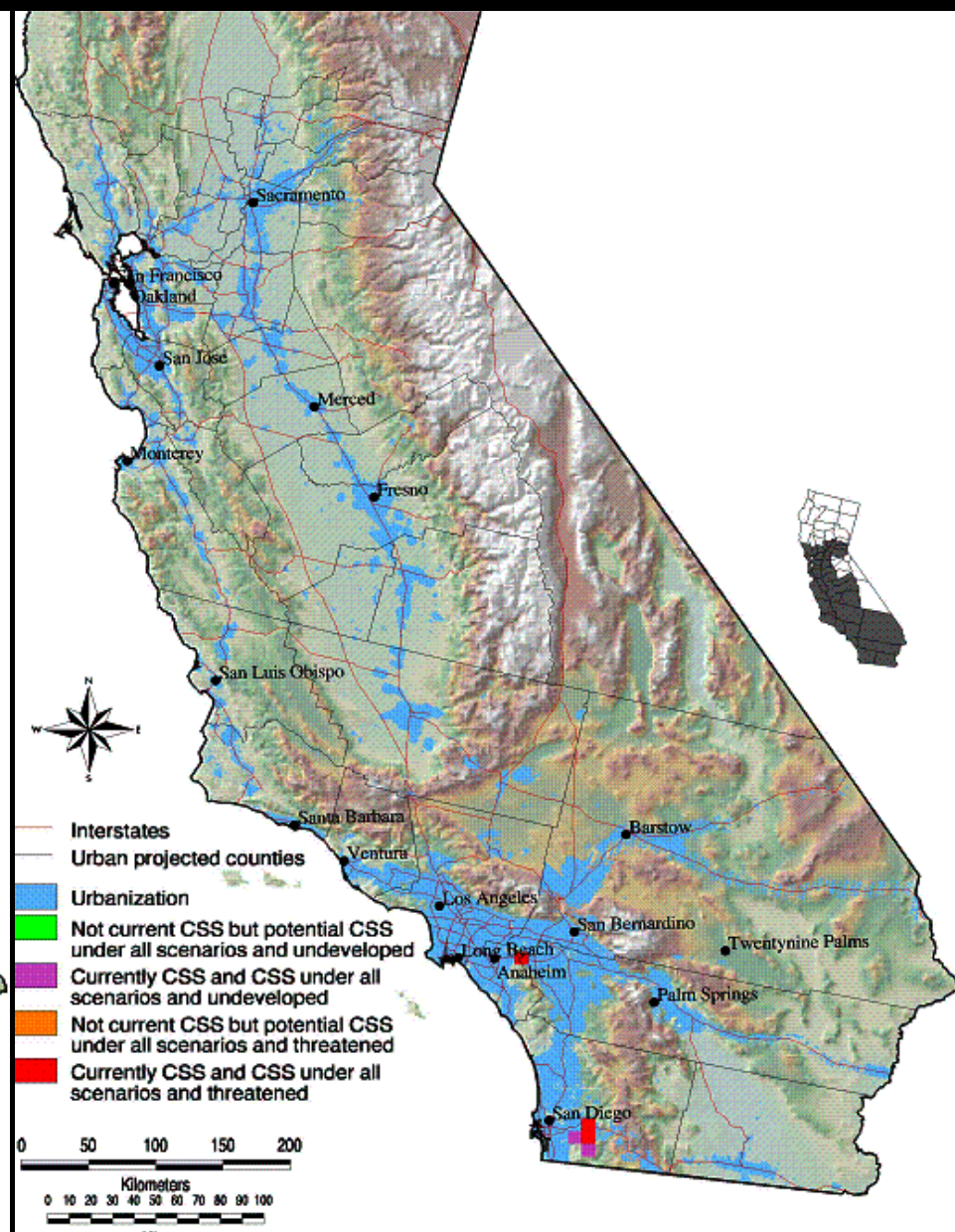
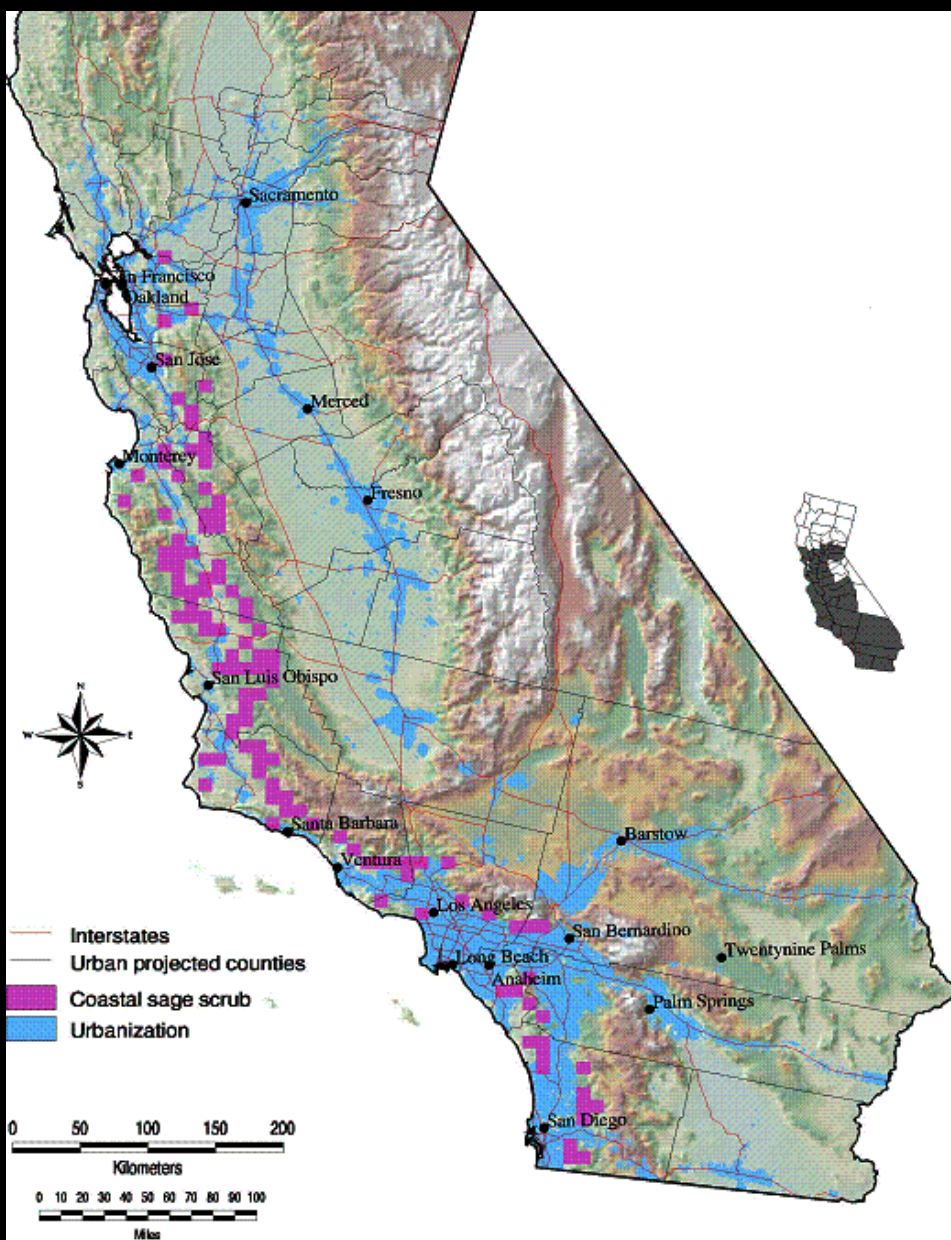
In the multi-model ensemble mean there is a transition to a sustained drier climate that begins in the late 20th and early 21st centuries. In the ensemble mean both  $P$  and  $E$  decrease



**Figure ES.2. Monthly mean rim inflows for the 12 climate scenarios and historical data.**

From: J.R. Lund et al., *Climate Warming and California's Water Future*, in Joel B. Smith and Robert Mendelshon (eds.) *The Impact of Climate Change on Regional Systems: A Comprehensive Analysis of California*. (Elgar, 2007).





# GOING TO THE EXTREMES

## AN INTERCOMPARISON OF MODEL-SIMULATED HISTORICAL AND FUTURE CHANGES IN EXTREME EVENTS

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TABLE II

Summary of comparisons between observed and simulated trends (1960–2000) at the global average scale, discussed in Sections 3 and 4

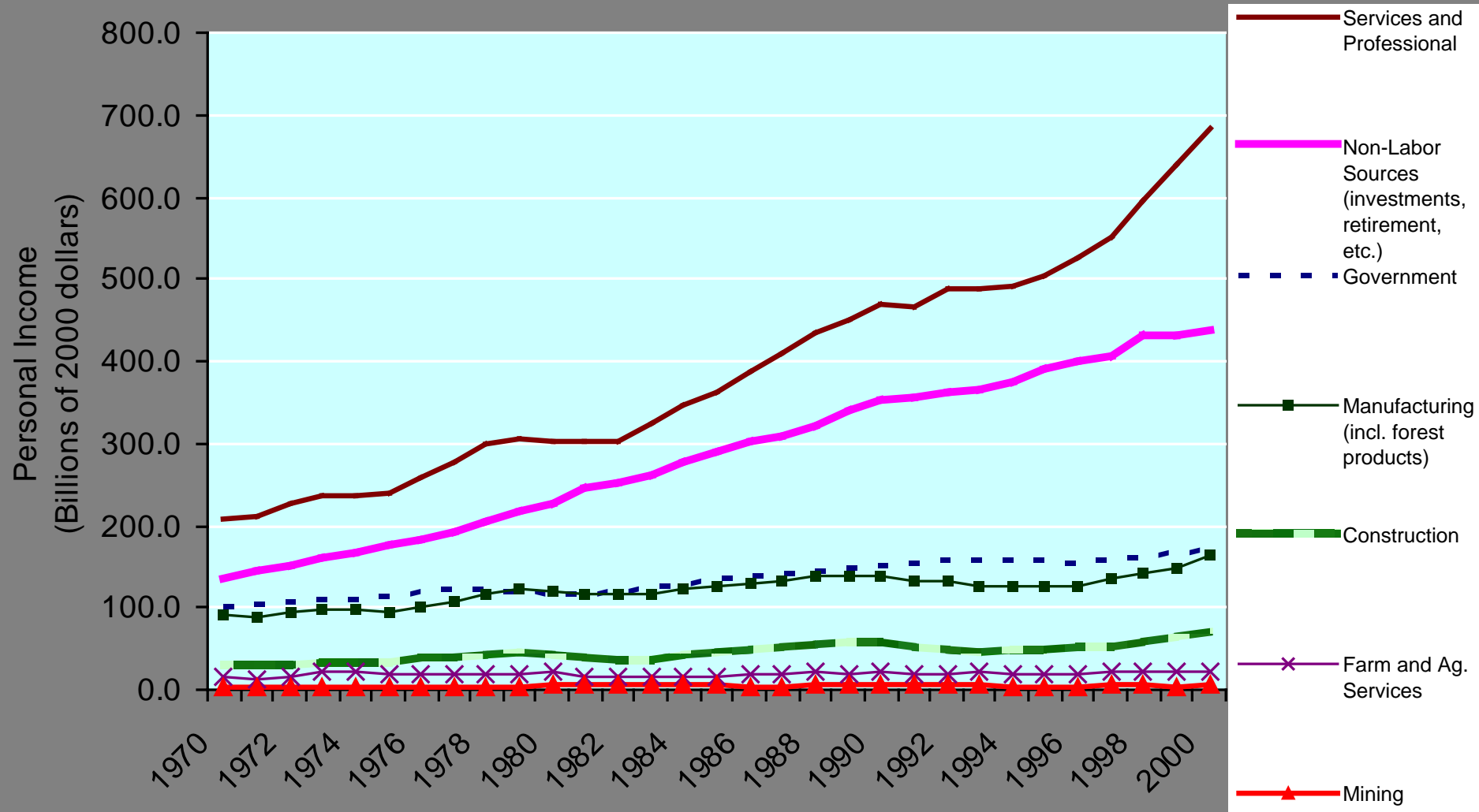
<i>Index</i>	Observed trends	Simulated trends
<i>Frost days</i>	Significant decreasing trend	Decreasing trend in all models Significant for a majority (Same for hemispheric averages)
<i>Xtemp range</i>	Significant decreasing trend	Decreasing trend in all models Significant for four models (SH sees disagreement in sign among models)
<i>Growing season</i>	Significant increasing trend	Increasing trend in all models Significant for a majority (Trends in SH flat for most models)
<i>Heat waves</i>	No significant trend	Increasing trend in all models Significant for four models (Same for hemispheric averages)
<i>Warm nights</i>	Significant increasing trend	Increasing trend in all models Significant for a majority (Same for hemispheric averages)
<i>Precip &gt;10</i>	Significant increasing trend	Increasing trend for all models Significant for a minority High inter-annual and inter-model variability
<i>Dry days</i>	Significant decreasing trend	Increasing trend for all models Significant for a minority High inter-annual and inter-model variability

# Looking to the Future

- A land use planning system that gets the geography right (one that bridges local to federal levels)
- Resilient vs. adaptive natural resource management and policies
  - Farm and commodities programs
  - NFMA
  - NFIP / Levees!

# Far West Region (AK, CA HI, NV, OR, WA)

## Personal Income by Industry, 1970 – 2000



Source: Sonoran Institute, based on US Bureau of Economic Analysis data